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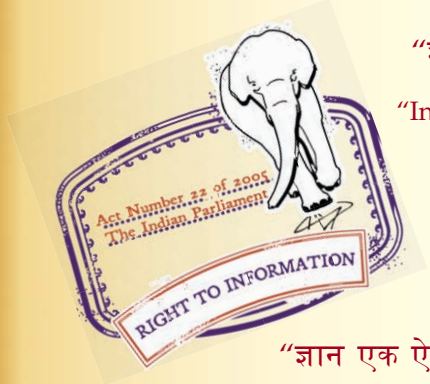

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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 8730 : 1997
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सतत सामग्री प्रहस्तन उपस्कर के सन्दर्भ में खुली सामग्रियों का वर्गीकरण और कोडीकरण

(पहला पुनरीक्षण)

Indian Standard

CLASSIFICATION AND CODIFICATION OF BULK MATERIALS FOR CONTINUOUS MATERIAL HANDLING EQUIPMENT

(First Revision)

ICS 53.040.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

November 1997

Price Group 8

Continuous Bulk Conveying, Elevating, Hoisting, Aerial Ropeways and Related Equipment Sectional Committee, HMD 6

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Continuous Bulk Conveying, Elevating, Hoisting, Aerial Ropeways and Related Equipment Sectional Committee had been approved by the Heavy Mechanical Engineering Division Council.

Bulk materials are conveyed by various types of material handling equipment, such as belt conveyors, chain conveyors, bucket elevators, pneumatic conveying equipment, etc. Bulk materials have different properties which affect the selection of these mechanical handling equipment. It is, therefore, imperative that the properties of bulk materials are studied in detail before an equipment is selected for a particular application. This Indian Standard is aimed to assist the manufacturer/supplier/purchaser to understand the material characteristics completely without any communication gap so that the equipment is selected/manufactured for optimum efficiency during operations.

In the preparation of this Indian Standard, considerable assistance has been derived from ISO 3435 : 1977 'Continuous mechanical handling equipment — Classification and symbolization of bulk materials'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off values should be the same as that of the specified value in this standard.

Indian Standard

CLASSIFICATION AND CODIFICATION OF BULK MATERIALS FOR CONTINUOUS MATERIAL HANDLING EQUIPMENT

(First Revision)

1 SCOPE

This standard lays down the classification and codification of bulk materials being handled by continuous material handling equipment.

2 TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in **2.1** to **2.3** shall apply.

2.1 Angle of Repose

Angle of repose of a material is the angle which the surface of a normal freely formed pile makes with the horizontal plane when the surface is on static condition.

2.2 Angle of Surcharge

Angle of surcharge of a material is the angle with the horizontal plane which the surface of the material assumes while the material is at rest but the supporting horizontal plane is moving. This is lower than the angle of repose at rest and is generally taken as 15° to 20° less than of the angle of repose at rest for moving planes only. Angle of surcharge under oscillating conditions vary widely and shall be determined on individual basis based on experience.

2.3 Lumpiness

It is characterized by the highest linear dimensions of uniform praticles (lumps) of a bulk load in a given volume (sample).

3 PROPERTIES OF MATERIALS

3.1 Moisture Content, W_m

The moisture content of a bulk material, W_m (in percent), is the ratio of the mass of water contained in it, which can be removed by drying sample at a temperature of +105 °C, to the mass of the dry sample:

$$W_m = \frac{(m_m - m_d) \times 100}{m_d}$$

where

m_m = mass of the moist sample, and

m_d = mass of the dry sample.

3.2 Abrasiveness

Abrasiveness of particles of a bulk material is their capability of wearing (eroding) the contacting surfaces of chutes, belts, chain links and other elements of conveying machines.

3.3 Strength

The strength of particles of a bulk material is determined by the ultimate strength in compression, σ_c, and is characterised by the strength coefficient on a specified scale:

$$\text{Strength coefficient} = \frac{\sigma_c}{10}$$

3.4 Slumping

Slumping of some bulk materials, that is the loss of mobility of their particles on long storage is an annoying property, especially in storage of materials in hoppers, conveyor bins and the like containers.

3.5 Stickiness

Stickiness is the capacity of some bulk material to stick to solids and surfaces.

4 CLASSIFICATION/CODIFICATION

4.1 Material Class Description

The materials may be distinguished as classified or non-classified as follows:

a) *Classified materials* — These are the materials for which the ratio between the size of the largest, a_{max}, and smallest lump, a_{min}, is less than or equal to 2.5.

b) *Non-classified materials* — These are the materials for which ratio a_{max}/a_{min} is greater than 2.5.

4.1.1 Classified materials are adequately defined by the values a_{max} and a_{min}. Non-classified materials, however, require, in most cases, a complete sieve analysis in which the ratio of the lump size shall not exceed 2.5. The grading inscription shall, at least, indicate

the proportion (by mass) of the lumps between 0.8 a_{max} and a_{min}. a_{max} and a_{min} being the size of the largest and the smallest lump which can be found in the material.

4.2 A bulk material may be classified by its size, flowability, abrasiveness and other characteristics.

4.2.1 The flowability of a material as measured by its angle of repose and angle of surcharge, determines the cross-section of the material load which may be carried safely on a belt. It is also an index of the safe angle of inclination of the belt conveyor.

4.2.2 The flowability is determined by characteristics such as the size and shape of the fine particles and lumps, toughness or smoothness of the surface of the material particles, proportion of fines and lumps present and moisture content of the material. The normal relationship of the above properties and the general characteristics are given in Table 1.

4.2.3 According to the lump size, a_{max}, bulk loads are divided into the following classes:

Class	*Description*	a_{max}
A	Dusty material	Up to 0.05 mm
B	Powdered material (fine sand)	0.05 - 0.50 mm
C	Granular material (grain)	0.5 - 10 mm
D	Small sized lumpy (crushed)	10 - 60 mm
E	Medium sized lumpy	60 - 200 mm
F	Large lump material	200 - 500 mm
G	Especially large lump size (such as stone, boulder, etc.)	Over 500 mm

4.2.4 Consideration shall also be given to the bulk density per cubic metre, dustiness, wetness, stickiness, abrasiveness, chemically corrosive action and temperature of bulk materials. The codification of the above characteristics is given in Table 2.

4.2.5 A material in a dense natural bed is in undisturbed state. The ratio of the density, ρ_b, of a material in a dense bed to its density in loosened condition is what is called the loosening factor, k_1:

$$k_1 = \frac{\rho_b}{\rho}$$

Table 1 Class Based on Flowability, Angle of Surcharge and Angle of Repose

(*Clause* 4.2.2)

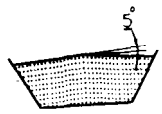
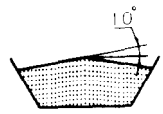
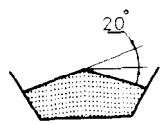
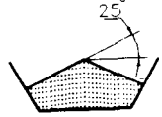
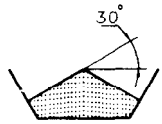
Class	Angle of Surcharge degrees	Angle of Repose degrees	Flowability	Material Characteristics	Illustration
1	5	Over 0 and up to 20	Very free flowing	Uniform size, very small rounded particles, either very wet or very dry, such as dry silica sand, cement, wet concrete, etc	
2	10	Over 20 and up to 30	Free flowing	Rounded, dry polished particles, of medium weight, such as whole grain and beans	
3	20	Over 30 and up to 35	Average flowing	Irregular, granular or lumpy materials of medium weight, such as anthracite coal, cotton-seed meal, clay, etc	
4	25	Over 35 and up to 40	Average flowing	Typical common materials, such as bituminous coal, stone, most ores, etc	
5	30	Over 40	Sluggish	Irregular, stringy, fibrous, interlocking materials such as wood chips, bagasse, tempered foundry sand, etc	

Table 2 Material Class Description

(*Clauses* 4.2.4, 4.2.5.1 *and* 4.2.6.1)

Material Characteristics	Description	Limitations	Class
Bulk density	Light	Up to 0.6 t/m³	H
	Medium	Over 0.6 up to 1.6 t/m³	I
	Heavy	Over 1.6 up to 2.0 t/m³	J
	Very heavy	Over 2.0 up to 4.0 t/m³	K
Abrasiveness	Non-abrasive	—	6
	Abrasive	—	7
	Very abrasive	—	8
	Very sharp	Cuts or gouges belt covers	9
Miscellaneous characteristics	Aerates and develops fluid (or dual operating) characteristics	—	L
	Contains explosive (or external) dust	—	M
	Sticky	—	N
	Contaminable affecting use or saleability	—	P
	Degradable, affecting use or saleability	—	Q
	Gives off harmful fumes or dust	—	R
	Highly corrosive	—	S
	Mildly corrosive	—	T
	Hygroscopic	—	U
	Oils or chemicals present	May affect rubber products	W
	Packs under pressure	—	X
	Very light and fluffy (or very high flowability and dusty)	May be wind swept	Y
	Elevated temperature	—	Z

NOTE — Sometimes more than one of these characteristics may apply.

4.2.5.1 The factor, k_1, is equal to 1.12 for sand, 1.4 for coal and 1.6 for ore. The density of a load depends on the size of the particles and moisture content. For lumpy and granular materials, this density decreases with decreasing particle size due to greater volume of air gaps between particles. According to their density, bulk materials are divided into four codes (*see* Table 2).

4.2.6 The degree of abrasiveness of a bulk material depends on the hardness, shape and size of its particles. The hardness of particles of bulk material is measured by a decimal hardness scale (Moh's scale) in which the hardness of various natural material is taken in relative units as follows:

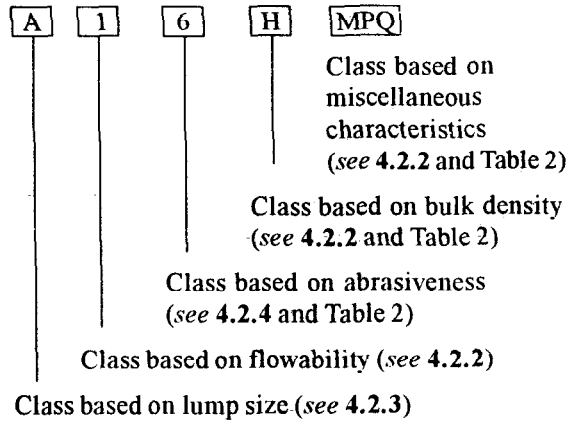
Talc 1, gypsum 2, lime feldspar 3, floorspar 4, ashphalt concentrate 5, quartzite 6-7, granite 6-8, saphire, corundum and chromium 9, diamond 10.

4.2.6.1 All bulk materials may be divided into four classes by the abrassive effects (*see* Table 2), they produce on conveyor elements.

4.2.7 The flowability of particles of a load (its angle of repose) determines the cross sectional area of the load on a moving belt or conveyor apron and the coefficient of lag of the load in the chute of a contoured flight conveyor. The coefficient of friction of bulk materials on steel, concrete, rubber, etc, are decisive for determining the angle of incline of walls and edges of bunkers, funnels and chutes and the maximum angles of inclination of the conveyor. The coefficient of internal friction of particle of bulk materials is associated with the angle of friction of the material by the relationship $f_i = \tan \rho_f$. The angles and coefficients of friction of bulk material at rest and in motion are different.

4.3 Codification

The code indicated in Table 3 for all materials is based on the following example:



4.4 Material Characteristics

Materials which are commonly handled in bulk are listed in Table 3. The values given in this table are for average conditions and average materials. Each characteristic may vary in specific instances, especially, angles of repose and maximum conveyor inclinations. Due consideration shall be given to materials that assume different characteristics under different conditions of processing, atmosphere, age and storage.

5 CHARACTERISTICS OF MATERIALS IN DYNAMIC CONDITION

It shall be noted that the normal characteristics of materials are considerably influenced by the movement, slope and speed of the conveyor belt that carries them.

5.1 As the conveyor belt passes successively over each carrying idler, the material on it is correspondingly agitated. This agitation tends to work the larger pieces to the surface of the load and the smaller particles or fines to the bottom. It also tends to flatten the material surface slope (that is the angle of surcharge) and explains why this angle is less than the angle of repose.

5.1.1 Any difference between the forward velocity of the material as it is being loaded and the conveyor belt that is receiving it, shall be equalized by the acceleration of the material. This acceleration causes turbulence in the material.

5.1.2 Any vertical velocity of the material as it is being loaded shall be absorbed in the resilient construction of the conveyor belt and the idlers used under the loading point. In this process, a further increase in material turbulence is produced.

5.1.3 These three influences are emphasized when the conveyor belt is on an incline or decline, and also when the conveyor belt is operated at high speeds. These influences are emphasized even more when the material handled is loose and contains large rounded lumps, such as coarse washed gravel, the tendency of which is to bounce and roll on the conveyor belt.

5.1.4 The nominal cross-section of the material on a horizontal conveyor belt is measured in a plane normal to the belt. On an inclined or declined conveyor belt, gravity necessitates that the actual cross-section of the load be considered in a vertical plane. The total width of the material load on the belt and the load possible on an inclined or declined belt shall be less than that on a horizontal belt.

5.1.5 The total effect is influenced by the surcharge angle at which the material will ride on the conveyor belt. However, in most cases, the actual loss of capacity is less than 30 percent.

5.1.6 The following are generally observed in a conveying system:

a) Lumps are more likely to roll off the edges of inclined conveyor belts than from horizontal ones.

b) For belts of constant slope, the spillage of material is more likely to occur immediately beyond the loading point.

c) Materials which aerate excessively, such as some very finely ground cements or materials in which the proportion of water is so high that a slurry is created, shall be carried on inclines and at such a conveyor belt speed that the tendency of the material to slide back is fully offset.

5.1.7 Table 4 shall be convenient to use when converting inclination angles in degrees-to-percent slope and when converting percent slope to inclination angles.

6 LIST OF CHARACTERISTICS TO BE FURNISHED WITH ENQUIRIES FOR QUOTATIONS FOR BULK MATERIAL HANDLING EQUIPMENT

The following information shall be provided when quotations are invited for selection of material handling equipment:

a) The common name of the material.

b) The bulk density defined as loose/vibrated,

c) The screen analysis,

d) The moisture content,

e) The material temperature,

f) Abrassiveness,

h) Lump size: Average/Minimum/Maximum, and

h) A verbal description of the appearance and characteristics of the material which may be useful in selecting the equipment.

Table 3 Material Characteristics and Codes

(*Clauses* 4.3 *and* 4.4)

Sl No.	Material	[1] Average Bulk Density, kg/m³	Angle of Repose, degrees	[2] Recommended Maximum Inclination degrees	[3] Code
1.	Adipic acid	720	—	—	A36UT
2.	Alfalfa seed	160-240	—	—	B16N
3.	Alfalfa meal	272	—	—	B57Y
4.	Almonds, broken or whole	448-480	—	—	C36Q
5.	Alum, fine	720-800	30-45	—	B36
6.	Alum, lumpy	800-960	—	—	D36
7.	Alum, pulverised	720-800	—	—	
8.	Alumina	800-1040	22	10-12	B27M
9.	Aluminate jell	720	—	—	B27
10.	Aluminium chips	110-240	—	—	E47Y
11.	Aluminium hydrate	288	34	20-24	C36
12.	Aluminium ore (*see* Bauxite)	—	—	—	
13.	Aluminium oxide	1 100-1 900	—	—	A17M
14.	Aluminium silicate	784	—	—	B36S
15.	Aluminium sulphate	860	32	17	C26
16.	Ammonium chloride, crystalline	832	30-35	16	B26S
17.	Ammonium nitrate	720-1 000	25	13	C37NUS
18.	Ammonium phosphate	990	29	15	C27
19.	Ammonium sulphate (granular)	720-928	—	—	C27S
20.	Ammonium sulphate nitrate (double salt)	—	34	16	
21.	Antimony powder	—	—	—	B37
22.	Apple pomace, dry	240	—	—	C57Y
23.	Arsenate of lead (*see* Lead arsenate)	—	—	—	
24.	Arsenic oxide	1 600-1 920	—	—	C29R
25.	Arsenic, pulverized	480	—	—	A27
26.	Asbestos ore or rock	1296	—	—	D28R
27.	Asbestos shred	320-400	—	—	E57XY
28.	Ash, black, ground	1680	32	17	B36
29.	Ashes, coal, dry, 12 mm and under	360-640	38	20-25	C57TY
30.	Ashes, coal, dry, 75 mm and under	560-640	38	20-25	D57T
31.	Ashes, coal, wet, 12 mm and under	720-800	50	23-27	C57T
32.	Ashes, coal, wet, 75 mm and under	720-800	50	23-27	C57T
33.	Ashes, fly	640-720	42	20-25	A58
34.	Ashes, gas-producer, wet	1248	—	—	D58

[1] Mass of material, loose or slightly agitated. Masses are usually different when materials are settled or packed as in bin or containers.

[2] The angle of inclination is for conventional belt conveyors which allow free rollback of material.

[3] Code may vary considerably due to conditions.

Table 3 (*Continued*)

Sl No.	Material	[1]Average Bulk Density, kg/m³	Angle of Repose, degrees	[2] Recommended Maximum Inclination degrees	[3] Code
35.	Asphalt, binder for paving	1 280-1 360	—	—	C56
36.	Asphalt, crushed, 12 mm and under	720	30-45	15-18	C36
37.	Bagasse	112-160	—	—	E56Y
38.	Bakelite and similar plastics (powdered)	480-640	—	—	B26
39.	Baking powder	656	—	18	A26
40.	Barite	2 880	—	—	D37
41.	Barium carbonate	1 152	—	—	A56
42.	Bark, wood, refuse	160-320	45	27	E57Y
43.	Barley	600-320	23	10-15	B16N
44.	Barytes, powdered	1 920-2 240	—	—	B27
45.	Barytes, lumpy	1 920-2 240	30	—	D27
46.	Bauxite, ground, dry	1 080	35	—	B27
47.	Bauxite, mine run	1 280-1 440	31	17	B38
48.	Bauxite, crushed, 75 mm and under	1 200-1 350	—	20	D38
49.	Beans, castor, whole	576	—	8-10	C26W
50.	Beans, navy, dry	678	—	—	C16
51.	Beans, navy, steeped	960	—	—	C26
52.	Beet pulp, dry	192-240	—	—	E56
53.	Beet pulp, wet	400-720	—	—	E57
54.	Beets, whole	768	—	—	D36
55.	Bentonite, crude	544-640	—	—	D57X
56.	Bentonite, 150 micron IS Sieve	800-960	—	20	A27XY
57.	Benzine hexachloride	896	45	20-25	A56R
58.	Bicarbonate of soda	656	30	15	A26
59.	Blood, dried	560-720	—	—	D57
60.	Bluestone (*see* copper sulphate)	—	—	—	—
61.	Bones, crushed	560-650	—	—	—
62.	Bones, granulated or ground	800	—	—	—
63.	Bones	544-640	—	—	—
64.	Bone black, 150 micron IS Sieve	320-400	—	—	A26Y
65.	Bone charcoal	432-640	—	—	B36
66.	Bone meal	880-960	—	—	B37
67.	Borate of lime	960	—	—	A36
68.	Borax, 50 mm to 75 mm lumps	960-1 040	30-45	18	D37
69.	Borax, 37 to 50 mm lumps	880-960	30-45	18	D37

[1] Mass of material, loose or slightly agitated. Masses are usually different when materials are settled or packed as in bin or containers.

[2] The angle of inclination is for conventional belt conveyors which allow free rollback of material.

[3] Code may vary considerably due to conditions.

Table 3 (*Continued*)

Sl No.	Material	[1]Average Bulk Density, kg/m³	Angle of Repose, degrees	[2]Recommended Maximum Inclination degrees	[3] Code
70.	Borax, 12 mm screenings	880-960	30-45	18-20	C37
71.	Borax, fine	850	—	—	B27T
72.	Boric acid, fine	880	—	—	B27T
73.	Boron	1 200	—	—	—
74.	Bran	256-320	30-44	—	B36M
75.	Bread crumbs	—	—	—	B37Q
76.	Brewer's grain, spent, dry	400-480	—	—	C56
77.	Brewer's grain, spent, wet	880-960	—	—	C56T
78.	Brick, hard	2 000	35	18	D58Z
79.	Brick, soft	1 600	35	18	D58
80.	Bronze Chips	480-800	—	—	B58
81.	Buckwheat	640-672	25	11-13	B26N
82.	Calcium acetate	2 000	—	—	—
83.	Calcium ammonium nitrate	—	28	14	—
84.	Calcium carbide (crushed)	1 120-1 280	30-45	—	D27N
85.	Calcium lactate	416-464	—	—	D56QTX
86.	Calcium oxide (*see* Lime)	—	—	—	—
87.	Carbon, activated, dry, fine	128-320	—	—	B26Y
88.	Carbon black, pelletized	640	28	—	C16Q
89.	Carbon black powder	64-112	21	—	A36Y
90.	Carborundum, 75 mm and under	1600	—	—	D28
91.	Casein	576	—	—	B36
92.	Cashew nuts	512-592	—	—	D57
93.	Cast iron chips	2 080-3 200	—	—	C50
94.	Cement, Portland	1 500	39	20-23	A27M
95.	Cement Portland, aerated	960-1 200	—	6	A17M
96.	Cement, rock (*see* Limestone)	1 600-1 760	—	—	D37
97.	Cement clinker	1 200-1 520	30-40	18-20	D38
98.	Cement mortar	2 128	—	—	38Q
99.	Chalk, lumpy	1 200-1 300	40-45	18	D57
100.	Chalk, 150 micron IS Sieve and under	1 120-1 200	40-45	20	A46MXY
101.	Charcoal	290-450	35	20-25	D39Q
102.	Cheese, grated	352-384	—	—	B36XY
103.	Chips, paper mill	320-400	—	—	E56
104.	Chips, paper mill, softwood	192-480	—	—	E56

[1] Mass of material, loose or slightly agitated. Masses are usually different when materials are settled or packed as in bin or containers.

[2] The angle of inclination is for conventional belt conveyors which allow free rollback of material.

[3] Code may vary considerably due to conditions.

Table 3 (*Continued*)

Sl No.	Material	[1]Average Bulk Density, kg/m³	Angle of Repose, degrees	[2] Recommended Maximum Inclination degrees	[3] Code
105.	Chips hogged, fuel	160-480	—	—	E56W
106.	Chocolate press cake	640-720	—	—	D26
107.	Chrome Ore (Chromite)	2 000-2 240	—	—	D28
108.	Cinders, Blast furnace	912	35	18-20	38T
109.	Cinders, coal	640	35	20	38T
110.	Clay (*see* also Bentonite, Diatomaceous earth, Fuller's earth, Kaolin and Marl)	—	—	—	—
111.	Clay, calcined	1280	—	—	B38
112.	Clay, dry, fines	1 600-1 920	35	20-22	C48
113.	Clay, dry, lumpy	960-1 200	35	18-20	D37
114.	Clinker, cement (*see* Cement clinker)	1 200-1 520	—	—	—
115.	Clover seed	768	28	15	B26N
116.	Coal, anthracite, river or culm, 3 mm and under	860	35	18	B36TY
117.	Coal, anthracite, sized	960	27	16	C27
118.	Coal, bituminous, mined, 300 micron sieve and under	960	45	24	B56T
119.	Coal, bituminous, mined, classified	960	35	16	D36QT
120.	Coal, bituminous, mined, unclassified	960	38	18	D36T
121.	Coal, bituminous, mined, slack, 12 mm and under	960	29-45	22	C56T
122.	Coal, bituminous, stripping, not cleaned	960	—	—	D37T
123.	Coal, Char	384	—	18	B37MN
124.	Coal, powdered	800-960	—	—	—
125.	Coal, pulverised	500-560	—	—	—
126.	Cocoa beans	480-640	28	—	C26Q
127.	Cocoa powder	480-560	26	—	C26
128.	Cocoanut, shredded	320-352	—	15	E57
129.	Coffee, shaff	320	—	—	E26MY
130.	Coffee, green bean	512	25	10-15	C26Q
131.	Coffee, ground	400	23	10	B26
132.	Coffee, roasted bean	352-416	—	—	C16
133.	Coffee, soluble	304	—	—	B56PQU
134.	Coke, loose	370-510	—	18	D57QT
135.	Coke, petroleum calcined	560-720	—	20	D37Y
136.	Coke breeze, 6 mm and under	400-560	30-45	20-22	C38Y

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Table 3 (*Continued*)

Sl No.	Material	[1]Average Bulk Density, kg/m³	Angle of Repose, degrees	[2]Recommended Maximum Inclination degrees	[3] Code
137.	Compost	448	—	—	E56ST
138.	Concrete, cinder	1 440-1 600	—	12-30	D67
139.	Concrete, 50 mm slump	1 760-2 400	—	24-26	D27
140.	Concrete, 100 mm slump	1 760-2 400	—	20-22	D27
141.	Concrete, 150 mm slump	1 760-2 400	—	12	D27
142.	Concrete, in place, stone	2 080-2 400	—	—	—
143.	Copper ore	1 920-2 400	—	18-20	D28
144.	Copper ore, crushed	1 600-2 400	—	20	D28
145.	Copper sulphate	1 200-1 360	31	17	D36
146.	Copperas (*see* Ferrous sulphate)	—	—	—	—
147.	Copra, lumpy	352	20	9	D26
148.	Copra cake, ground	640-720	30	16	B36W
149.	Copra cake, lumpy	400-480	20	8	D26W
150.	Copra meal	640-720	35-40	25	B36W
151.	Cork, fine ground	190-240	—	—	B56MY
152.	Cork, granulated	192-240	—	—	C56
153.	Corn, cracked	680-720	—	—	C26W
154.	Corn, speed	720	—	—	C16NQ
155.	Corn, ear	896	—	—	—
156.	Corn, shelled	720	21	10	C26MW
157.	Corn sugar	500	—	—	B36
158.	Corn germs	336	—	—	B26W
159.	Corn grits	640-720	—	—	—
160.	Cornmeal	600-640	35	19	D36W
161.	Cottonseed, dry de-linted	400	29	16	C26W
162.	Cottonseed, dry not de-linted	290-400	35	19	C36W
163.	Cottonseed cake, crushed	640-720	—	—	B36
164.	Cottonseed flakes	320-400	—	—	—
165.	Cottonseed cake, lumpy	640-720	—	—	D26W
166.	Cottonseed hulls	190	—	—	B56Y
167.	Cottonseed meal	560-640	35	22	B36W
168.	Cottonseed meats	640	—	—	B36W
169.	Cracklings, crushed, 75 mm and under	640-800	—	—	D56
170.	Cryolite dust	1 200-1 400	—	—	A37
171.	Cryolite, lumpy	1 440-1 600	—	—	D37

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Table 3 (*Continued*)

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172.	Cullet	1 280-1 600	—	20	D38SZ
173.	Culm (*see* Coal)	720-960	—	20	—
174.	Detergent (*see* Soap detergent)	—	—	—	—
175.	Diatomaceous earth	176-224	—	—	A37MY
176.	Dicalcium phosphate	688	45	—	A56
177.	Disodium phosphate	400-496	30-45	—	B27QT
178.	Dolomite, lumpy	1 440-1 600	—	22	D27
179.	Earth as excavated dry	1 120-1 280	35	20	B37
180.	Earth wet containing clay	1 600-1 760	45	23	B57
181.	Ebonite, crushed, 12 mm and under	1 040-1 120	—	—	C26
182.	Egg powder	256	—	—	—
183.	Emery	3 680	—	—	A28
184.	Epsom salts	640-800	—	—	B-26
185.	Face powder (*see* Talc)	640-960	—	—	—
186.	Feed, cattle and fowl	—	—	—	E56W
187.	Feldspar, ground, 3 mm and under	1 040-1 120	—	—	B37
188.	Feldspar, powdered	1 200	—	—	A57
189.	Feldspar, 12 mm screenings	1 120-1 360	38	18	B37
190.	Feldspar, 37 to 75 mm lumps	1 440-1 760	34	17	D37
191.	Feldspar, 75-micron IS Sieve	1 600	—	—	—
192.	Ferrous sulphate	800-1 200	30-45	—	C37
193.	Filter press mud (sugar factory)	1 120	—	—	16
194.	Fish meal	560-640	—	—	B56W
195.	Fish scrap	640-800	—	—	E56W
196.	Flax seed	720	21	12	B26MW
197.	Flaxseed cake, expeller	780-800	—	—	D36
198.	Flaxseed meal	400	—	—	B26W
199.	Flour, wheat	560-640	—	21	A56PN
200.	Flue dust, boiler house, dry	560-720	≤ 30	—	A18MTY
201.	Flue dust, blast furnace	1 760-2 000	—	—	B7
202.	Fluorspar	1 300	—	—	C57
203.	Flourspar, 12 mm screenings	1 360-1 680	—	—	C57
204.	Flourspar, 37 to 75 mm lumps	1 760-1 920	—	—	D57
205.	Fly ash, dry (*see* Flue dust)	—	—	—	—
206.	Foundry sand, loose (*see* Sand)	1 280-1 440	—	—	B58

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Table 3 (*Continued*)

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207.	Foundry refuse, old sand cores, etc	1 120-1 600	—	—	D37Z
208.	Fullers' earth, dry	480-560	23	—	B27
209.	Fullers' earth, oily	960-1040	—	—	B27
210.	Fullers' earth, oil filter, burned	640	—	—	B27
211.	Fullers' earth, oil filter, raw	560-640	35	20	B27
212.	Fullers' earth, oil filter, 300 spent	960-1040	—	—	—
213.	Garbage, green	480	—	—	—
214.	Garbage, household	800	—	—	E56W
215.	Gelatin, granulated	512	—	—	C26Q
216.	Gilsonite	592	—	—	C27NT
217.	Glue, ground, 3 mm and under	640	—	—	C27
218.	Glue, pearl	640	25	11	C26
219.	Glue, vegetable, powdered	640	—	—	—
220.	Glass batch	1 280-1 600	30-45	20-22	D39Z
221.	Gluten meal	640	—	—	B26P
222.	Grain, distillery, spent, dry	480	—	—	E26WY
223.	Granite, 12 mm screenings	1 280-1 440	40	20	C28
224.	Granite, 37 to 75 mm lumps	1 360-1 440	35	18	D28
225.	Granite, broken	1 500-1 600	35	18	D28
226.	Graphite, flake	640	—	—	C26
227.	Graphite, flour	640	—	—	A26M
228.	Grape pomace	240-320	—	—	C57Y
229.	Grass seed	160-195	—	—	B26NY
230.	Gravel, bank run	1 440-1 600	38	20	—
231.	Gravel, pebbles	1 440-1 600	35	15-17	D28
232.	Gravel	1 520-2 160	30	—	D37
233.	Gypsum, calcined, 12 mm and under	880-960	40	—	C37
234.	Gypsum, calcined, powdered	960-1 280	45	—	A57
235.	Gypsum, dust non-aerated	1 488	—	—	—
236.	Gypsum, dust, aerated	960-1120	42	16-23	A37Y
237.	Gypsum, 12 mm screening	1 120-1 280	40	21	C37
238.	Gypsum, 37 to 75 mm lumps	1 120-1 280	30	—	D27
239.	Gypsum, raw, 25 mm and under	1 440-1 600	—	—	D37
240.	Guano, dry	1 120	—	—	B27
241.	Gunpowder	1 008	—	—	D26T

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Table 3 (*Continued*)

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242.	Hay, loose	80	—	—	B56NY
243.	Hominy	592	45	—	C26
244.	Hops, spent, dry	560	—	—	E36
245.	Hops, spent, wet	800-880	—	—	E36T
246.	Ice, crushed	560-720	30	—	D17
247.	Ilmenite ore	2 240	—	—	B28
248.	Iron borings, machine shop	2 000	—	—	D58WZ
249.	Iron ore	1 600-3 200	35	18-20	D37
250.	Iron ore, crushed	2 160-2 400	—	20-22	C27
251.	Iron ore, pellets	2 500-2 880	20	12	D28 & D28Z
252.	Iron oxide, pigment	400	40	25	A56
253.	Iron sulphate (*see* Ferrous sulphate)	—	—	—	—
254.	Kaolin clay, 75 mm and under	1 010	35	19	D37
255.	Kaolin talc, 150-micron IS Sieve	672-896	45	23	A57Y
256.	Lactose	512	—	—	A26PX
257.	Lamp black (*see* Carbon black)	—	—	—	—
258.	Lead arsenate	1 152	—	—	B56R
259.	Lead ores (Galena)	3 200-4 320	30	15	B36RT
260.	Lead oxides	480-2 400	—	—	B63
261.	Lignite, air dried	720-880	—	—	D26
262.	Lignite, raw, heavy	900-960	38	22	D37T
263.	Lime ground, 3 mm and under	960	43	23	B56X
264.	Lime, hydrated	560-720	40	21	—
265.	Lime, hydrated, 3 mm and under	640	40	21	B36MXY
266.	Lime, hydrated, pulverized	512-640	42	22	A36MXY
267.	Lime, over 12 mm	850	30	17	—
268.	Lime, pebble	1280	30	17	D36
269.	Limestone	1 360-1 440	30-45	—	—
270.	Limestone, agricultural, 3 mm and under	1 088	30-35	20	B27
271.	Limestone, crushed	1 360-1 440	38	20	A26M
272.	Limestoe, dust	1 360-1 520	38-45	18	A57M
273.	Linseed cake, pea size	800	—	—	C56W
274.	Linseed meal	680	34	20	B26
275.	Litharge (*see* Lead oxide)	—	—	—	—

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Table 3 (*Continued*)

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276.	Litharge, pulverized (Lead oxide)	3 200-4 000	—	—	—
277.	Lithopone	720-800	—	—	A26M
278.	Magnesite, fines	1 040-1 200	350	—	A28M
279.	Magnesium chloride	528	—	—	C57
280.	Magnesium sulphate	1 120	—	—	—
281.	Maize (*see* Corn)	—	—	—	—
282.	Malt, dry ground, 3 mm and under	320-355	—	—	B26NR
283.	Malt, dry whole	430-480	—	—	C26N
284.	Malt, wet or green	960-1040	—	—	C56
285.	Malt, meal	570-640	—	—	B26
286.	Malt, sprouts	240	—	—	—
287.	Malt, wet or green	640-720	—	—	C56
288.	Manganese dioxide	1280	—	—	—
289.	Manganese ore	2 000-2 240	39	20	D38
290.	Manganese sulphate	1 120	—	—	C28
291.	Marble, crushed, 12 mm and under	1 440-1 520	—	—	D28
292.	Marl, dry	1 280	—	—	C28
293.	Meat scraps	640	—	—	E36W
294.	Meat ground	800-880	—	—	—
295.	Mica, ground	208-240	24	23	B37
296.	Mica, pulverized	320-480	—	—	A27MY
297.	Mica, flakes	272-352	—	—	B17MY
298.	Milk, dried, flake	575	—	—	B26MPY
299.	Milk, dry powder	576	45	—	B26P
300.	Milk, malted	430	—	—	A36PX
301.	Milk, whole, powdered	320	—	—	B36PUXY
302.	Mill scale	—	—	—	E57T
303.	Milo maize	896	—	—	C16N
304.	Molybdenite, powdered	1 712	40	25	B26
305.	Mortar, wet	2 400	—	—	B57T
306.	Muriate of potash	1 232	—	—	B28
307.	Mustard seed	720	—	—	B16
308.	Monosodium phosphate	800	—	—	B37
309.	Mushrooms	384	—	—	—
310.	N.P.K. (fertilizer)	950	26-30	15	—

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Table 3 (*Continued*)

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311.	Mustard seed	720	—	—	B16N
312.	Naphthalene flakes	720	—	—	—
313.	Nilacin-Nickle	560	—	—	B27
314.	Nickle ore	2 400	—	—	B28T
315.	Nickel-cobalt sulphate ore	1 120-1 280	—	—	D28T
316.	Nitrophosphate (Sulpha)	900	30	15	—
317.	Oats	416	21	10	C28M
318.	Oats, rolled	304	—	—	C26NY
319.	Oil cake	768-800	—	—	D56W
320	Ore (*see* Iron ore)	—	—	—	—
321.	Orange peel, dry	2240	—	—	H56
322.	Oxalic acid, crystals	960	—	—	B36SU
323.	Oyster shells, ground, under 12 mm	848	—	—	C37T
324.	Oyster shells, whole	1280	—	—	D37TY
325.	Paper pulp stock	640-960	—	—	E16M
326.	Paper pulp, 10 percent consistency	720-800	—	—	—
327.	Paper pulp stock, up to 15 percent	960-1 000	—	—	—
328.	Paper pulp, 20 percent consistency	400-480	—	—	—
329.	Paper pulp, 30 percent consistency	160-240	—	—	—
330.	Paraffin cake, broken	720	—	—	—
331.	Peanuts, in shells	240-320	—	—	D26Q
332.	Peanuts shelled	560-720	—	—	C26Q
333.	Peas, dried	720-800	—	—	C16NQ
334.	Pebbles, over 25 mm	1 440-1 600	—	—	—
335.	Petroleum coke (*see* Coke)	—	—	—	—
336.	Phosphate acid, fertilizer	1 440	26	13	B26TQ
337.	Phosphate, acid, pulverized	1 040-1 120	—	—	—
338.	Phosphate, granular	1 440	—	—	—
339.	Phosphate, triple, super, ground fertilizer	800-880	45	30	B56T
340.	Phosphate rock, broken, dry	1 200-1 360	25-30	12-15	D27
341.	Phosphate rock, pulverized	960	40-52	25	B37
342.	Phosphate sand	1 440-1 600	30-45	—	—
343.	Phosphate, diammonium	880	—	—	—
344.	Phosphate, florida	1 490	27	—	—
345.	Pitch	800-1 150	27-35	18	CD36

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Table 3 (*Continued*)

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346.	Plaster of Paris (*see* Gypsum, calcined, powdered)	—	—	—	—
347.	Polystyrene beads	640	—	—	B26
348.	Potash salts, sylyite, etc	1 280	—	—	B26T
349.	Potassium carbonate	816	30-45	—	C27T
350.	Potassium chloride, pellets	1 920-2 080	30-45	—	C17T
351.	Potassium nitrate	1 216	< 30	—	C17T
352.	Potassium sulphate	672-768	45	—	B47X
353.	Pumice, 3 mm and under	672-720	—	—	B58
354.	Pyrites, iron, 50 to 75 mm lumps	2 160-2 320	—	—	D27T
355.	Pyrites, pellets	1 920-2 080	30-45	—	C27T
356.	Quartz, dust	1 120-1 280	—	—	A27Y
357.	Quartz, pulverised or granular	1 760	—	—	B8
358.	Quartz, 12 mm screenings	1 280-1 440	—	—	C28Z
359.	Quartz, 37 to 75 mm lumps	1 360-1 520	—	—	D28Z
360.	Rice bran (*see* Bran)	320	—	—	—
361.	Rice, hulled or polished	720-768	20	8	B16
362.	Rice, rough	576	—	—	B26M
363.	Rice grits	670-720	—	—	B36
364.	Rock, crushed	2 000-2 320	—	—	D27
365.	Rock, soft, excavated with shovel	1 600-1 760	—	22	D37
366.	Rough, powder	—	—	—	—
367.	Rubber, ground	370	—	—	—
368.	Rubber, pellets	830-880	35	22	E56
369.	Rubber, reclaim	400-480	32	18	D56
370.	Rye	704	23	8	B16N
371.	Salicylic acid	464	—	—	B26U
372.	Salt, common dry, coarse	720-800	30-45	18-22	C27TU
373.	Salt, common dry, fine	1 120-1 280	25	11	D27TUW
374.	Salt, cake, dry, coarse	1 360	36	21	B37TW
375.	Salt, cake, dry, pulverized	1 040-1 360	35	—	B26NT
376.	Saltpeter	1 280	—	—	—
377	Sand, bank, damp	1 760-2 080	45	20-22	C57Q
378.	Sand, bank, dry	1 440-1 760	35	16-18	C37
379.	Sand, foundry, prepared	1 440	39	22	D38
380.	Sand, foundry, shakeout	1 440	39	22	D38

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381.	Sand, silica, dry	1 440-1 600	30-35	10-15	B28
382.	Sand, core	1 440	41	26	B46X
383.	Sandstone, broken	1 360-1 440	—	—	D38
384.	Sawdust	240-320	36	22	B46
385.	Sesame seed	432	—	—	B27
386.	Sewage (sludge)	960	30-40	20	E26TW
387.	Shale, broken	1 440-1 600	40	—	D27QZ
388.	Shale, crushed	1 360-1 440	39	22	C37
389.	Shellac	1 280	—	—	C46
390.	Shellac, powdered or granulated	496	—	—	B26PY
391.	Silica (*see* Sand)	1 440-1 600	—	—	B28
392.	Silica gel	720	30-45	—	B38
393.	Single superphosphate, granulated	—	37	17	—
394.	Sinter	1 600-2 160	37	18	D28
395.	Slag, blast furnace, crushed	1 280-1 440	25	10	A28
396.	Slag, furnace, granular, dry	960-1 040	25	13-16	C28
397.	Slag, furnace, granular, wet	1 440-1 600	45	20-22	P58
398.	Slag, furnace, lumpy	2 560-2 880	—	—	D58
399.	Slate, dust	1 120-1 280	35	20	A37Y
400.	Slate, crushed, 3 mm and under	1 312	—	—	B37
401.	Slate, lumps 37 to 75 mm	1 360-1 440	28	15	C27
402.	Slate, lumps 37 to 75 mm	1 360-1 440	—	—	D27
403.	Slurry (*see* Cement)	—	—	—	—
404.	Snow, compacted by rain	240-960	—	—	—
405.	Snow, fresh fallen	80-192	—	—	—
406.	Soap beads or granules	—	—	—	B26Q
407.	Soap chips	240-400	30	18	C36Q
408.	Soap detergents	240-800	—	—	—
409.	Soap flakes	160-320	—	—	B36QXY
410.	Soap powder	320-400	—	—	B26X
411.	Soapstone, talc, fine	640-800	—	—	A56XY
412.	Soda ash, briquettes	800	22	7	C27
413.	Soda ash, heavy	880-1 040	35	19	C37
414.	Soda ash, light	320-580	37	22	A56Y
415.	Sodium bicarbonate	256	42	23	A56Y

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Table 3 (*Continued*)

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416.	Sodium nitrate	1 120-1 280	24	11	D26
417.	Sodium phosphate	800-1 040	—	—	—
418.	Sodium aluminium sulphate	1 200	31	18	
419.	Sodium sulphate (*see* Salt cake)	—	—	—	—
420.	Sorghum seed	752-832	—	—	C38
421.	Soyabeans, cracked	510-580	35	15-18	B27NW
422.	Soyabeans, whole	720-800	21-28	12-16	C27NW
423.	Soyabean cake, over 12 mm	640-688	32	17	D36W
424.	Soyabean flakes, raw	320-416	—	—	C26Y
425.	Soyabean flakes, spent	288-320	—	—	C36Y
426.	Soyabean flour	480	—	—	AN
427.	Soyabean meal, cold	640	32-37	16-20	B36
428.	Soyabean meal, hot	640	—	—	B36T
429.	Starch	720	24	12	B26
430.	Steel chips, crushed	1 600-2 400	—	—	D28WZ
431.	Steel trimmings	1 200-2 400	35	18	E38
432.	Stone, crushed	1 360-1 440	—	—	—
433.	Sugar, granulated	800-880	—	—	B26QUT
434.	Sugar, powdered	800-960	—	—	B36PTY
435.	Sugar, raw, cane	880-1 040	—	—	B57TX
436.	Sugar, wet, beet	880-1 040	—	—	B37TX
437.	Sugar, cane, knifed	240-288	—	—	E56
438.	Sugar, refined	800-880	—	—	—
439.	Sugar, beet, pulp, dry	170-240	—	—	—
440.	Sugar, beet, pulp, wet	170-240	—	—	—
441.	Sulphate, powdered	800-960	—	21	B26NW
442.	Sulphate, crushed, 12 mm and under	800-960	—	20	C26NS
443.	Sulphate, 75 mm and under	1 280-1 360	—	18	D26NS
444.	Sulphur, coarsed	880-1 360	32	16	—
445.	Sulphur, crushed	880-960	30-45	16	C36MS
446.	Sulphur, powdered	880-960	30-45	21	B36MW
447.	Taconite, pellets	1 856-2 080	—	13-15	D18Q
448.	Talc, powdered	640-960	—	—	A26MY
449.	Talc, 42 mm screenings	1 280-1 440	—	—	C26
450.	Talc, 37 to 75 mm lumps	1 360-1 520	—	—	D26

[1] Mass of material, loose or slightly agitated. Masses are usually different when materials are settled or packed as in bin or containers.

[2] The angle of inclination is for conventional belt conveyors which allow free rollback of material.

[3] Code may vary considerably due to conditions.

Table 3 (*Concluded*)

Sl No.	Material	[1]Average Bulk Density, kg/m³	Angle of Repose, degrees	[2] Recommended Maximum Inclination degrees	[3] Code
451.	Talc, solid	2640	—	—	—
452.	Tallow	928	—	—	—
453.	Timothy seed	576	—	—	B26NY
454.	Titanium dioxide	400	—	—	—
455.	Tanbark, ground	880	—	—	—
456.	Tankage	960-1 120	—	—	—
457.	Titanium sponge	960-1 120	—	—	E58
458.	Tobacco leaves, dry	192-224	—	—	E56QY
459.	Tobacco scraps	240-400	—	—	D56Y
460.	Tobacco snuff	480	—	—	B56MQ
461.	Tobacco stems	400	—	—	E56Y
462.	Traprook. crushed	1 680-1 760	—	—	D38
463.	Traprook, 12 mm screenings	1 440-1 600	—	—	C38
464.	Traprook, 50 to 75 mm lumps	1 600-1 760	—	—	D37
465.	Trisodium phosphate	960	30-45	—	B26
466.	Trisodium phosphate, granular	960	26	11	B26
467.	Trisodium phosphate, pulverized	800	40	25	B36
468.	Triple super phosphate	800-880	30-45	—	B37RS
469.	Tung nut meats, crushed	400	—	—	D26
470.	Urea, prills	700	23-27	13	C26SU
471.	Vermiculite, expanded	256	—	—	C36Y
472.	Vermiculite ore	1 280	—	20	D37Y
473.	Walnut shells, crushed	560-640	—	—	B38
474.	Wheat	720-768	28	12	C26N
475.	Wheat, cracked	640-720	—	—	B26N
476.	Wheat germ	448	—	—	B26W
477.	Wood bark (*see* Bark)	—	—	—	—
478.	Wood chips	290-320	—	27	E56WY
479.	Wood flour	256-576	—	—	—
480.	Wood shavings	128-240	—	—	E56
481.	Zinc dust	3 200	—	—	—
482.	Zinc concentrates	1 200-1 280	—	—	B27
483.	Zinc ore, crushed	2 560	38	22	—
484.	Zinc ore, roasted	1 760	38	—	C37
485.	Zinc oxide, heavy	480-560	—	—	A36X
486.	Zinc oxide, light	160-240	—	—	A36XY

[1] Mass of material, loose or slightly agitated. Masses are usually different when materials are settled or packed as in bin or containers.

[2] The angle of inclination is for conventional belt conveyors which allow free rollback of material.

[3] Code may vary considerably due to conditions.

Table 4 Conversion From Degree to Rise Millimetre per metre and Percent Rise

(*Clause* 5.1.7)

Inclination, Degrees	Rise, per m, mm[1)]	Percent Rise	Inclination, Degrees	Rise, per m, mm[1)]	Percent Rise
1/4	4.3	0.43	22	404.3	40.43
1/2	8.7	0.87	23	424.4	42.44
3/4	13.0	1.30	24	445.2	44.52
1	17.4	1.74	25	466.3	46.63
2	34.9	3.49	26	487.7	48.77
3	52.4	5.24	27	505.9	50.59
4	69.9	6.99	28	531.7	53.17
5	87.4	8.74	29	554.3	55.43
6	105.1	10.51	30	577.3	57.73
7	122.7	12.27	31	600.8	60.08
8	140.5	14.05	32	624.8	62.48
9	158.3	15.83	33	649.4	64.94
10	176.3	17.63	34	674.5	67.45
11	194.4	19.44	35	700.2	70.02
12	212.5	21.25	36	726.5	72.65
13	230.8	23.08	37	753.5	75.35
14	249.4	24.94	38	781.2	78.12
15	267.9	26.79	39	809.7	80.97
16	286.7	28.67	40	839.1	83.91
17	305.7	30.57	41	869.2	86.92
18	324.9	32.49	42	900.4	90.04
19	344.3	34.43	43	932.5	93.25
20	363.9	36.39	44	965.6	96.56
21	382.8	38.28	45	1 000.0	100.00

[1)] Vertical rise in millimetre per metre of horizontal projection.

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